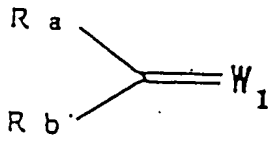
Claims

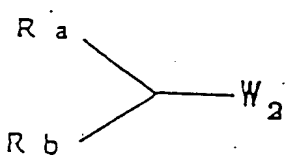
1. A method for producing optically active compounds, comprising subjecting a compound represented by the following formula (I);



(I)

(wherein Ra and Rb independently represent a linear or cyclic hydrocarbon group or heterocyclic group, which may or may not have a substituent; W_1 represents oxygen atom, N-H, N-Rc, N-OH or N-O-Rd; and Rc and Rd independently represent a linear or cyclic hydrocarbon group or heterocyclic group, which may or may not have a substituent),

to transfer-type asymmetric reduction in the presence of a transition metal complex and an optically active nitrogen-containing compound or a transition metal complex with an optically active nitrogen-containing compound as an asymmetric ligand, along with a hydrogen-donating organic or inorganic compound, to produce an optically active compound represented by the following formula (II);

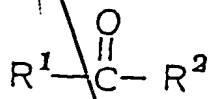


(II)

(wherein Ra and Rb independently represent the same as those described above; W_2 represents OH, NH_2, NH-Rc, NH-OH or NH-O-Rd; and Rc and Rd independently represent the same as those described above).

2. A production method according to claim 1, wherein the hydrogen transfer-type reduction is carried out in the coexistence of base.

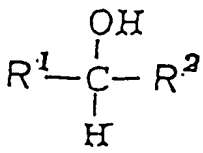
3. A production method for producing optically active alcohols according to claim 1, comprising asymmetrically reducing a carbonyl compound represented by the following formula (III);



(III)

(wherein R^1 represents an aromatic hydrocarbon group, a saturated or unsaturated aliphatic hydrocarbon group or cyclic aliphatic hydrocarbon group, which may or may not have a substituent, or a heterocyclic group which may or may not have a substituent and contains hetero atoms such as nitrogen, oxygen, sulfur atoms and the like as atoms composing the ring; R^2 represents hydrogen atom, a saturated or unsaturated aliphatic hydrocarbon group or cyclic aliphatic hydrocarbon group which

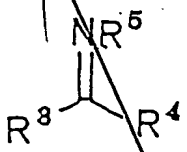
may or may not have a substituent, or an aromatic hydrocarbon group, or the same heterocyclic group as described above; and R^1 and R^2 may satisfactorily be bonded together to form a ring), to produce optically active alcohols represented by the following formula (IV);



(IV)

(wherein R^1 and R^2 are the same as described above).

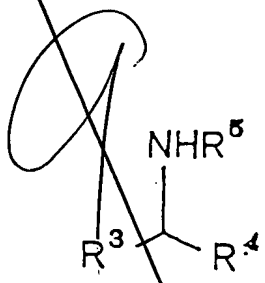
4. A method for producing optically active amines according to claim 1, comprising asymmetrically reducing an imine compound represented by the following formula (V);



(V)

(wherein R^3 represents an aromatic hydrocarbon group, a saturated or unsaturated aliphatic hydrocarbon group or cyclic aliphatic hydrocarbon group, which may or may not have a substituent, or a heterocyclic group which may or may not have a substituent and contains hetero atoms such as nitrogen, oxygen, sulfur atoms and the like as atoms composing the ring; R^4 represents hydrogen atom, a saturated or unsaturated aliphatic hydrocarbon group or cyclic aliphatic hydrocarbon group which

may or may not have a substituent, or an aromatic hydrocarbon group, or the same heterocyclic group as described above; R^5 represents hydrogen atom, or a saturated or unsaturated aliphatic hydrocarbon group or cyclic aliphatic hydrocarbon group, which may or may not have a substituent, or an aromatic hydrocarbon group, or the same heterocyclic group as described above, or the hydrocarbon group or heterocyclic group bonded together via hydroxyl group or oxygen atom; and R^3 and R^4, R^3 and R^5 or R^4 and R^5, are bonded together to form a ring), to produce optically active amines represented by the following formula (VI);



(VI)

(wherein R^3, R^4 and R^5 are the same as described above).

5. A production method according to claim 1, wherein the transition metal catalyst is a metal complex of metals of group VIII.

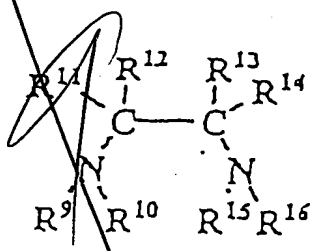
6. A production method according to claim 5, wherein the metal complex is represented by the following formula;

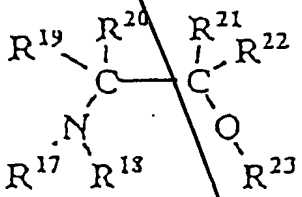
MXmLn

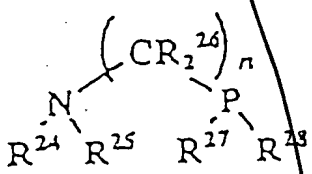
wherein M represents transition metals of group VIII, such as

iron, cobalt, nickel, ruthenium, rhodium, iridium, osmium, palladium and platinum; X represents hydrogen, halogen atom, carboxyl group, hydroxy group and alkoxy group and the like; L represents neutral ligands such as aromatic compounds and olefin compounds; and m and n represent an integer.

7. A production method according to claim 1, wherein the optically active nitrogen-containing compounds are optically active amine derivatives represented by any one of the following formulas;







(wherein R^9, R^{10}, R^{15} and R^{16} are independently hydrogen, a saturated or unsaturated hydrocarbon group, urethane group or

sulfonyl group; R^{11}, R^{12}, R^{13} and R^{14} are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center and independently represent hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; any one of R^{11} and R^{12} and any one of R^{13} and R^{14} are bonded together to form a ring;

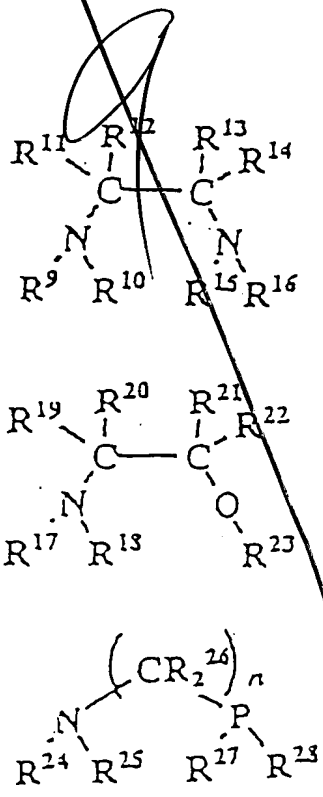
at least one of R^{17} and R^{18} is hydrogen atom, and the remaining one is hydrogen atom, a saturated or unsaturated hydrocarbon group, urethane group or sulfonyl group; R^{19}, R^{20}, R^{21} and R^{22} are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center and independently represent hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or a cyclic hydrocarbon group; R^{23} represents hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; furthermore, any one of R^{19} and R^{20} and any one of R^{21} and R^{22} may satisfactorily be bonded together to form a ring or any one of R^{17} and R^{18} and any one of R^{20} and R^{21} may satisfactorily be bonded together to form a ring;

R^{24} and R^{25} are independently hydrogen atom, a saturated or unsaturated hydrocarbon group, urethane group, sulfonyl group or acyl group; $(CR_2^{26})_n$ are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center; R^{26} represents hydrogen atom, an aromatic

group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; R^{27} and R^{28} independently represent hydrogen atom, and a saturated or unsaturated hydrocarbon group.

8. A production method according to claim 5, wherein the metal of group VIII is ruthenium.

9. A production method according to claim 1, wherein the transition metal catalyst with an optically active nitrogen-containing compound as an asymmetric ligand is a metal complex of metals of group VIII wherein an optically active amine derivative represented by any one of the following formulas is used as the ligand;



(wherein R^9, R^{10}, R^{15} and R^{16} are independently hydrogen, a

saturated or unsaturated hydrocarbon group, urethane group or sulfonyl group; R^{11}, R^{12}, R^{13} and R^{14} are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center and independently represent hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; any one of R^{11} and R^{12} and any one of R^{13} and R^{14} are bonded together to form a ring;

at least one of R^{17} and R^{18} is hydrogen group, and the remaining one is hydrogen atom, a saturated or unsaturated hydrocarbon group, an aryl group, urethane group or sulfonyl group; R^{19}, R^{20}, R^{21} and R^{22} are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center and independently represent hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; R^{23} represents hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; furthermore, any one of R^{19} and R^{20} and any one of R^{21} and R^{22} may satisfactorily be bonded together to form a ring or any one of R^{17} and R^{18} and any one of R^{20} and R^{21} may satisfactorily be bonded together to form a ring;

R^{24} and R^{25} are independently hydrogen atom, a saturated or unsaturated hydrocarbon group, urethane group, sulfonyl group or acyl group; $(CR_2^{26})_n$ are the same or different so that the carbon bonded with these substituent groups might occupy the

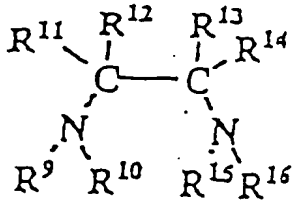
asymmetric center; R^{26} represents hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; R^{27} and R^{28} independently represent hydrogen atom, and a saturated or unsaturated hydrocarbon group.

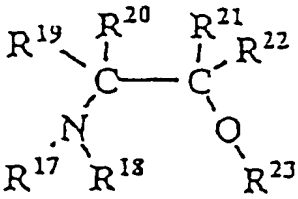
10. A production method according to claim 8, wherein the metal of group VIII is ruthenium.

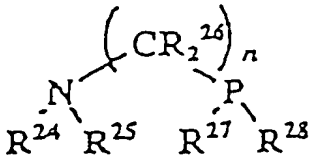
11. A production method according to claim 1, wherein the hydrogen-donating organic or inorganic compounds include alcohol compounds, formic acid, formate salts, hydrocarbon compounds, heterocyclic compounds, hydroquinone or phosphorous acid.

12. A production method according to claim 2, wherein the base is a hydroxide of an alkali metal or an alkali earth metal or a salt thereof or a quaternary ammonium salt.

13. An optically active catalyst composed of a transition metal catalyst and an optically active amine derivative represented by any one of the following formulas;







(wherein R^9, R^{10}, R^{15} and R^{16} are independently hydrogen, a saturated or unsaturated hydrocarbon group, urethane group or sulfonyl group; R^{11}, R^{12}, R^{13} and R^{14} are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center and independently represent hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; any one of R^{11} and R^{12} and any one of R^{13} and R^{14} are bonded together to form a ring;

at least one of R^{17} and R^{18} is hydrogen atom, and the remaining one is hydrogen atom, a saturated or unsaturated hydrocarbon group, urethane group or sulfonyl group; R^{19}, R^{20}, R^{21} and R^{22} are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center and

independently represent hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; R^{23} represents hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; furthermore, any one of R^{19} and R^{20} and any one of R^{21} and R^{22} may satisfactorily be bonded together to form a ring or any one of R^{17} and R^{18} and any one of R^{20} and R^{21} may satisfactorily be bonded together to form a ring;

R^{24} and R^{25} are independently hydrogen atom, a saturated or unsaturated hydrocarbon group, urethane group, sulfonyl group or acyl group; $(CR_2^{26})_n$ are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center; R^{26} represents hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; R^{27} and R^{28} independently represent hydrogen atom, and a saturated or unsaturated hydrocarbon group.

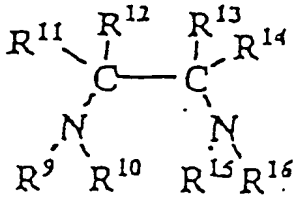
14. A catalyst according to claim 13, wherein the transition metal complex is a complex of metals of group VIII as represented by the following general formula;

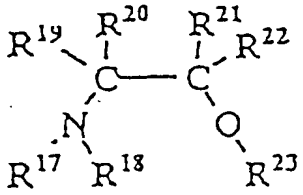
MXmLn

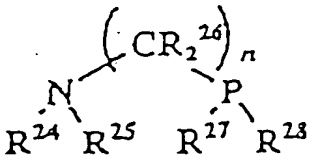
(wherein M represents transition metals of group VIII, such as iron, cobalt, nickel, ruthenium, rhodium, iridium, osmium, palladium and platinum; X represents hydrogen, halogen atom, carboxyl group, hydroxy group and alkoxy group and the like;

L represents neutral ligands such as aromatic compounds and olefin compounds; and m and n represent an integer).

15. An optically active catalyst composed of a transition metal catalyst and an optically active amine derivative represented by any one of the following formulas;







(wherein R^9, R^{10}, R^{15} and R^{16} are independently hydrogen, a saturated or unsaturated hydrocarbon group, urethane group or sulfonyl group; R^{11}, R^{12}, R^{13} and R^{14} are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center and independently represent hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; any one of R^{11}

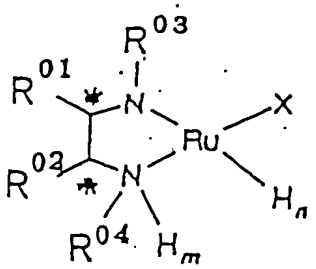
and R^{12} and any one of R^{13} and R^{14} are bonded together to form a ring;

at least one of R^{17} and R^{18} is hydrogen atom, and the remaining one is hydrogen atom, a saturated or unsaturated hydrocarbon group, urethane group or sulfonyl group; R^{19}, R^{20}, R^{21} and R^{22} are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center and independently represent hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; R^{23} represents hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; furthermore, any one of R^{19} and R^{20} and any one of R^{21} and R^{22} may satisfactorily be bonded together to form a ring or any one of R^{17} and R^{18} and any one of R^{20} and R^{21} may satisfactorily be bonded together to form a ring;

R^{24} and R^{25} are independently hydrogen atom, a saturated or unsaturated hydrocarbon group, urethane group, sulfonyl group or acyl group; $(CR_2^{26})_n$ are the same or different so that the carbon bonded with these substituent groups might occupy the asymmetric center; R^{26} represents hydrogen atom, an aromatic group, a saturated or unsaturated hydrocarbon group or cyclic hydrocarbon group; furthermore, R^{27} and R^{28} independently represent hydrogen atom, and a saturated or unsaturated hydrocarbon group.

16. A catalyst according to claim 15, wherein the transition metal complex is a complex of metals of group VIII.

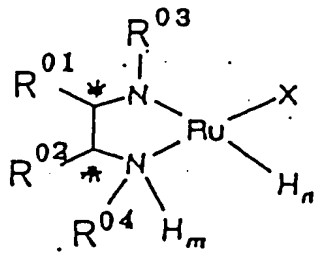
17. An optically active catalyst according to claim 16, wherein the transition metal catalyst is an optically active ruthenium-diamine complex represented by the following general formula (VII);



(VII)

(wherein * represents an asymmetric carbon atom; R^{01} andR^{02} are the same or different, independently representing alkyl group, or phenyl group or cycloalkyl group which may or may not have an alkyl group; or R^{01} and R^{02} together form an alicyclic ring unsubstituted or substituted with an alkyl group; R^{03} represents methanesulfonyl group, trifluoromethanesulfonyl group, naphthylsulfonyl group, camphor sulfonyl group, or benzenesulfonyl group which may or may not be substituted with an alkyl group, an alkoxyl group or halogen atom, or benzoyl group which may or may not be substituted with alkoxycarbonyl group or alkyl group; R^{04} represents hydrogen atom or alkyl group; X represents an aromatic compound which may or may not be substituted with an alkyl group; and m and n together represent 0 or 1).

18. An optically active ruthenium-diamine complex, represented by the following general formula (VII);



(VII)

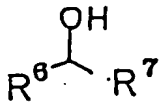
(wherein * represents an asymmetric carbon atom; R^{01} andR^{02} are the same or different, independently representing alkyl group, or phenyl group or cycloalkyl group which may or may not have an alkyl group; or R^{01} and R^{02} together form an alicyclic ring unsubstituted or substituted with an alkyl group; R^{03} represents methanesulfonyl group, trifluoromethanesulfonyl group, naphthylsulfonyl group, camphor sulfonyl group, or benzenesulfonyl group which may or may not be substituted with an alkyl group, an alkoxyl group or halogen atom, or benzoyl group which may or may not be substituted with alkoxycarbonyl group or alkyl group; R^{04} represents hydrogen atom or alkyl group; X represents an aromatic compound which may or may not be substituted with an alkyl group; and m and n together represent 0 or 1).

19. An optically active ruthenium-diamine complex according to claim 18, wherein R^{01} and R^{02} are independently phenyl group

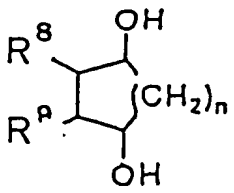
or together form an alicyclic ring, unsubstituted or substituted with an alkyl group.

20. A method for producing optically active secondary alcohols, comprising subjecting racemic secondary alcohols or meso-type diols to hydrogen transfer reaction in the presence of an optically active ruthenium-diamine complex catalyst according to claim 17.

21. A method according to claim 20, comprising the reaction of racemic secondary alcohols or meso-type diols represented by the following formulas (VIII) and (IX);



(VIII)



(IX)

(wherein R^6 represents an aromatic monocyclic or polycyclic hydrocarbon group, unsubstituted or substituted or a hetero monocyclic or polycyclic group containing hetero atoms, or ferrocenyl group; R^7 represents hydrogen atom, a saturated or unsaturated hydrocarbon group, or a functional group containing hetero atoms; or R^6 and R^7 may be bonded together to form a saturated or unsaturated alicyclic group giving a cyclic ketone

and the alicyclic group may or may not be substituted; R^8 and R^9 furthermore independently represent a saturated or unsaturated hydrocarbon group which may or may not have a substituent, or R^7 and R^9 may be bonded together to form a saturated or unsaturated alicyclic group which may or may not have a substituent; and n is 1 or 2).